IS 7810 (1999): Code of practice for radiographic examination of resistance spot welds on aluminium and its alloys [MTD 21: Non-Destructive Testing]

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भारतीय मानक

एल्यूमिनियम एवं उसके मिश्रधातुओं पर प्रतिरोध बिन्दु वेल्ड के रेडियोग्राफी परीक्षण के लिए रीति संहिता

(पहला पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR RADIOGRAPHIC EXAMINATION OF RESISTANCE SPOT WELDS ON ALUMINIUM AND ITS ALLOYS

(First Revision)

ICS 25.160.40

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

April 1999

Price Group 3

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This Indian Standard was first published in the year 1975, while reviewing this standard, it was decided that this Indian Standard may be revised taking note of the present practices followed in the country in this field.

The resistance spot welds of lap joints in aluminium and its alloys are basically different from fusion welded butt joints. The main difference is in the method of joining the tube plates together. Consequently, characteristics of the two types are quite different including the types of defects in the welds.

This standard is based on ISO 3777 : 1976 'Radiographic inspection of resistance spot welds for aluminium and its alloys and recommended practice'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CODE OF PRACTICE FOR RADIOGRAPHIC EXAMINATION OF RESISTANCE SPOT WELDS ON ALUMINIUM AND ITS ALLOYS

(First Revision)

1 SCOPE

1.1 This standard prescribes the method for radiographic examination of spot welded lap joints in aluminium and its alloy by using X-rays as the source of radiation.

1.2 The standard should not be considered as an acceptance standard for welds. The limits of acceptance of defects revealed by the method given in this standard may be mutually agreed to between the contracting parties prior to radiography.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
812 : 1957	Glossary of terms relating to welded and cutting of metals
2478 : 1991	Glossary of terms relating to industrial radiology (*second revision*)
2595 : 1978	Code of practice for radiographic testing (*first revision*)
2598 : 1966	Safety code for industrial radiographic practice
3657 : 1978	Radiographic image quality indicator (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 812 and IS 2478 shall apply.

4 PROTECTION OF I ERSONNEL

As exposure of any part of the human body to X-rays may become highly injurious to health, it is essential that whenever X-ray equipment or radioactive sources are in use, adequate precautions should be taken to protect the radiographer and any other person in the vicinity as per details given in IS 2598.

5 WELD SURFACE PREPARATION

Generally no surface preparation is required.

6 LOCATION OF THE WELD ON THE RADIOGRAPH

Markers usually in the form of fine lead arrows should be placed along both sides of the spot weld to identify the exact position of the welds on the radiograph.

7 MARKING ON THE WORKPIECES

The nature of the workpieces do not normally permit stamping. Electro or mechanical etching, if permissible, by the job specifications, may be employed for marking on the workpieces, if this is not permissible, painting on workpieces or maintaining accurate location sketches may be employed.

8 OVERLAP OF FILMS

The radiograph of continuous spot welds should provide for sufficient overlap to ensure radiography of every spot weld.

9 IMAGE QUALITY INDICATORS

An image quality indicator conforming to IS 3657 should be placed at one or both ends of every section radiographed on the surface facing the source of radiation and adjacent to the weld, thinnest step or wire of image quality indicator being placed away from the weld. Only where this surface is inaccessible should image quality indicator be placed on the film side. In such cases, a lead letter '*F*' shall be placed by the side of image quality indicator and it shall be mentioned within report. The type of image quality indicator and the minimum sensitivity of radiograph shall be agreed to between the contracting parties. These values merely provide a guide to the quality of the technique used and do not necessarily bear any direct relationship to the acceptability levels of defects in welds.

10 FILMS

The films should be of nonscreen, fine or ultra-fine grain and high contract type.

11 SCREENS

11.1 The use of fluorescent screen (salt screen) is not permitted.

11.2 Up to 50 kV, no lead screen is to be used as the intensifying role of the screen is negligible.

11.3 Front screen is not necessary since spot welds are mostly radiographed at well below 100 kV. However, in some cases a front lead screen of 0.02 to 0.05 mm for films exposed between 50 and 100 kV will improve the image quality.

11.4 A lead back screen of 0.2 mm or more may be used to reduce the effects of radiation diffused by objects behind the cassette.

11.5 Paper cassettes are preferable to metallic cassettes or plastic cassettes as thickness of spot welds are low. The metallic cassettes absorb considerable radiation. For curved surfaces flexible cassettes are recommended.

12 RADIOGRAPHIC TECHNIQUES

12.1 Focus-Film Distance

The focus-film distance f, depends on the focal spot dimension d, film to workpiece distance b, and the acceptable geometric unsharpness U (*see* Fig. 1).

$$f = \frac{b(d+U)}{U}$$

or approximately $f = \frac{bd}{U}$

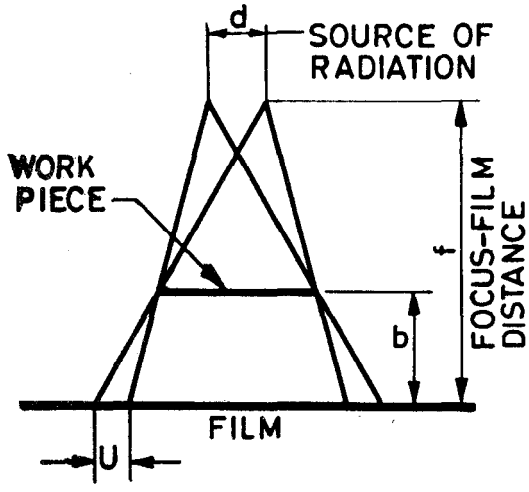


FIG. 1 RELATIONSHIP BETWEEN FOCUS-FILM DISTANCE OF FOCAL SPOT DIMENSION (d), FILM TO WORKPIECE DISTANCE (b), AND GEOMETRIC UNSHARPNESS (U)

12.1.1 Film to workpiece distance 'b' should be as small as possible. When the film is in close contact with the workpiece b is practically equal to thickness of weld being radiographed.

12.1.2 However, in double wall double image technique, b will be the external diameter of the tube and not the wall thickness.

12.1.3 Focus-film distance 'f' should be selected on the basis of a value U, as 0.25 mm. A focal spot dimension of 2 × 2 mm will be sufficient to achieve this value for U.

12.2 Alignment of Beam

Generally the beam axis of a radiation should be directed to the middle of spot weld and perpendicular to the surface at the point.

12.2.1 For double wall double image technique, the beam should be inclined such that the two images are not superimposed.

12.2.2 For double wall single image technique, the beam should be inclined at an appropriate angle (source S, Fig. 7) or may be placed direct over the pipe (source S, Fig. 7).

12.3 Shielding from Scattered Radiation

A lead sheet of not less than 1.5 mm thickness should be place behind the cassette. Lead masking of the workpiece shall be done so that radiation is restricted only to the area under examination.

12.4 Density of the Radiograph

Including a fog density of 0.2 the minimum value of density should be 2, for spot weld radiography, a maximum value is not specified and higher densities can be used provided a suitable high intensity illuminator is available.

12.5 Size of the Area Covered

The maximum size of the exposed area should be such that density in the entire film area is acceptable minimum value of 2.

12.6 Tube Value

The X-ray tube voltage shall be kept as low as possible so as to achieve a better contrast. However, relatively high currents shall be used in order to have short exposure time. For the purpose of keeping short exposure time, X-ray tubes with beryllium windows are preferable.

12.7 Film and Source Positions

12.7.1 *Flat Lap Weld Joints*

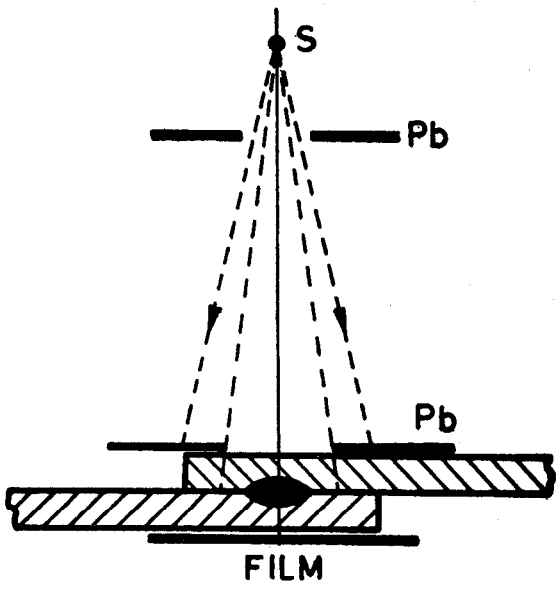
Since both sides are accessible, simple method illustrated in Fig. 2 is to be used.

12.7.2 *Circular Lap Weld Joints*

These can be either longitudinal or transverse spot welds as illustrated in Fig. 3.

12.7.2.1 *Film inside source outside*

Source is directed perpendicular to centre of film



S – Source of radium
Pb – Lead mask

FIG. 2 RADIOGRAPHY OF FLAT LAP WELD JOINTS

placed inside. This method is possible only when space is available for fixing the films inside (*see* Fig. 4).

12.7.2.2 *Film outside and source inside*

The X-ray source is placed inside and, in the case of a continuous length of transverse welds (*see* Fig. 5A), preferably with the focus situated in the centre of the hollow body. The film is outside, its centre corresponding with the axis of the X-ray beam. The technique, when applicable gives the best results for welds on periphery of hollow cylindrical bodies, because the different parts of the film are situated at the same distance from the source, thus enabling uniform density to be obtained. However, for this technique, it is necessary either to use special equipments (rod type anode tube) or to have workpiece with sufficient diameter to enable the tube to be placed inside it.

12.7.2.3 *Film and source outside (double wall, double image technique)*

This is to be used for diameters below 100 mm. The beam axis is inclined to the surface of the weld. The

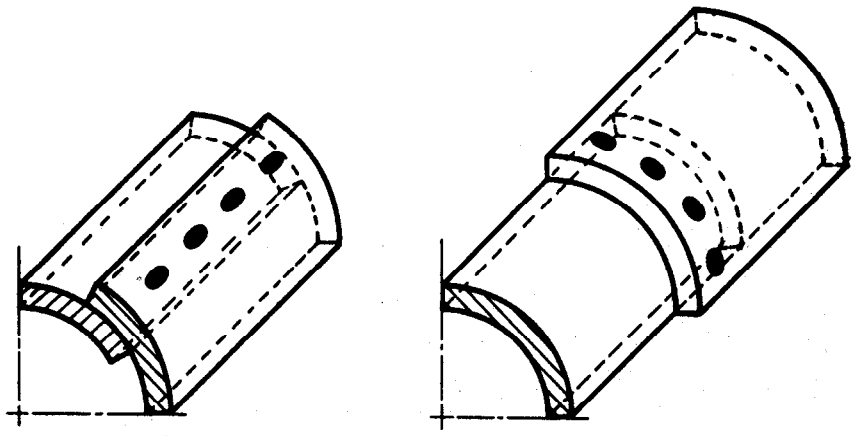


FIG. 3 CIRCULAR LAP WELD JOINTS

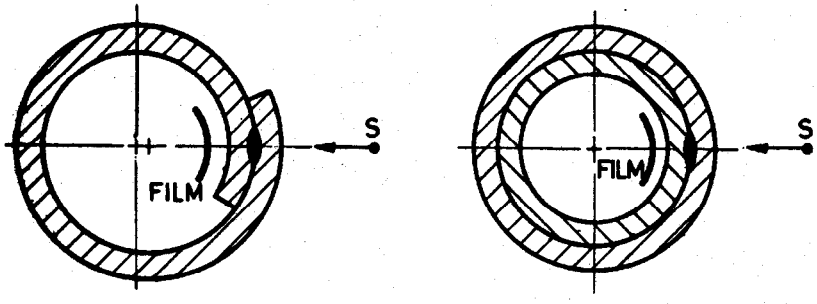


FIG. 4 FILM INSIDE, SOURCE OUTSIDE

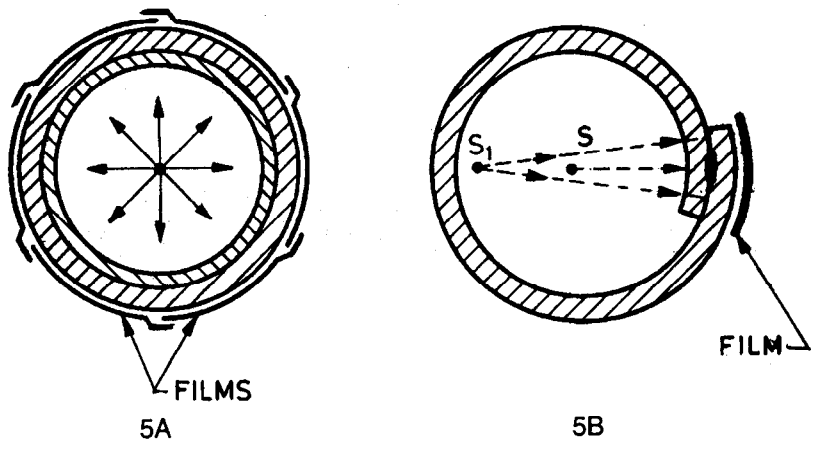


FIG. 5 FILM OUTSIDE AND SOURCE INSIDE

film should be placed on the surface opposite to that facing the source (*see* Fig. 6).

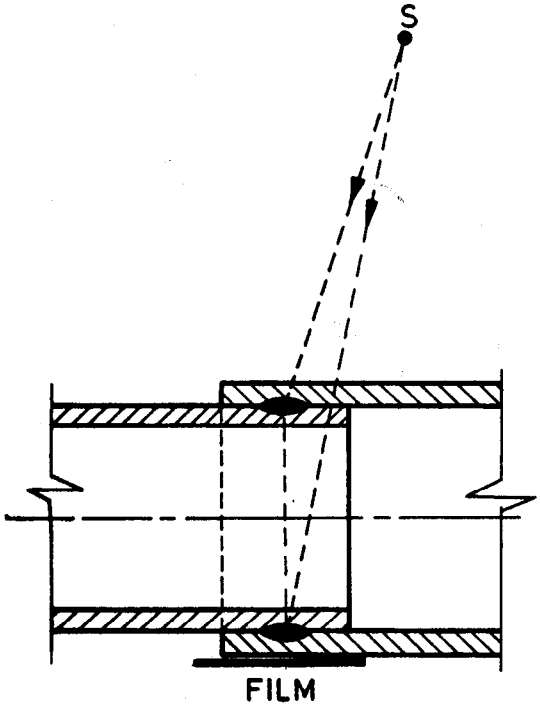


FIG. 6 FILM AND SOURCE OUTSIDE — DOUBLE WALL DOUBLE IMAGE TECHNIQUE

12.7.2.4 *Film and source outside (double wall, single image technique)*

This is to be used for diameters between 100 and 900 mm. Above this value the surface to film distance becomes too high. The beam axis is inclined to the surface of the weld (*see* Fig. 7).

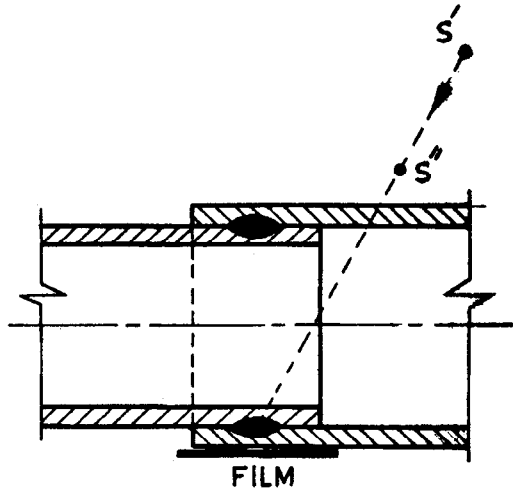


FIG. 7 FILM AND SOURCE OUTSIDE — DOUBLE WALL SINGLE IMAGE TECHNIQUE

13 PROCESSING

13.1 The films should be processed according to the recommendations of the manufacturer of films. The radiographs should be free of any processing faults which would interfere with the interpretation.

13.2 For further details regarding processing reference may be made to IS 2595.

14 VIEWING

14.1 The radiographs should be examined in a darkened room on a diffusing screen and the illuminated area should be marked to the minimum

required for viewing the image of the film. For densities greater than 2, a high intensity illuminator of variable intensity control is to be used.

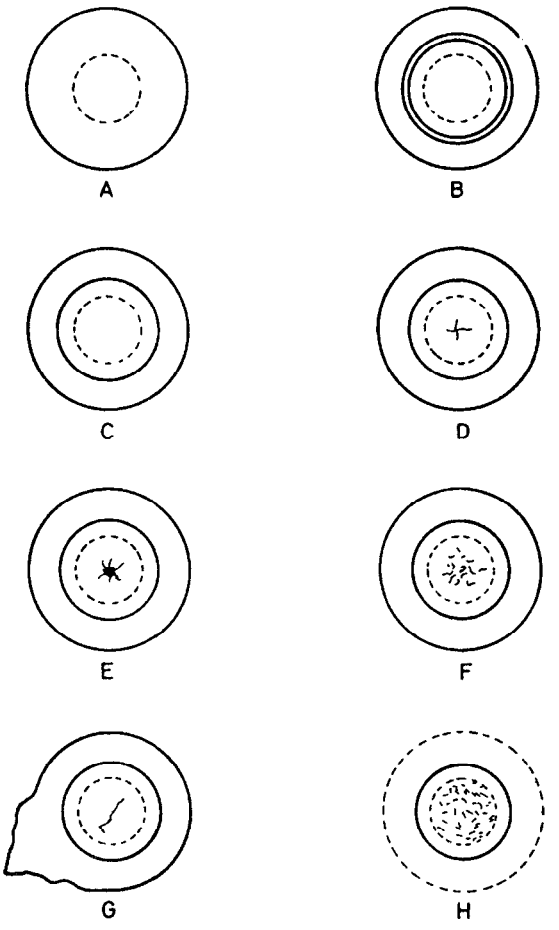
15 RECORD OF TECHNICAL DATA

For each radiographs or a set of radiographs information should be available on the technique used. The following minimum information should be recorded:

a) Identification No./Drawing No.;
b) Tube voltage and current used;
c) Object thickness;
d) Time of exposure;
e) Type of film and screen;
f) Film density and sensitivity;
g) Source to film distance;
h) System of marking used;
j) Position of image quality indicator whether source side or film side;
k) Film processing details; and
m) Date of radiography.

16 INTERPRETATION

In spot welding, certain special defects occur. During the formation of a spot weld the alloying constituents tend to migrate into zones which are shown on the radiographs as rings of different density. The image of the rings can be used as a criterion of weld quality. A thin, well-defined dark ring outlines the diameter of the fused nugget and outside this, a light forona corresponds to the heat-affected and welding pressure zone, those two rings should be clearly visible. A smaller diameter of dark ring corresponds to reduction of penetration, greater radial thickness of the light zone corresponds to reduction of penetration, as does less differentiation of two zones. In the case of imperfect bonding the ring may be non-existent. Figure 8 shows sketches of the radiographic appearance of some typical defects.



NOTE — Sketches showing radiographic appearance of spot-welds in aluminium and its alloys.

A – No bonding (no dark ring)
B – Partial bonding (two rings)
C – Good weld
D – Cracked weld
E – Cavity in weld
F – Porosity in weld
G – Extrusion (on left side)
H – Burn through

FIG. 8 TYPICAL DEFECTS IN SPOT WELDING

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Review of Indian Standards

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